# Greenhouse Gas Inventory for the City of Bloomington, Indiana:

## Footprint, Projections, and Recommendations

May 2009

City of Bloomington Environmental Commission,
City of Bloomington Commission on Sustainability,
City of Bloomington Office of the Mayor

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**Acknowledgements**: This report was prepared in consultation with the Bloomington Environmental Commission/Bloomington Commission on Sustainability Greenhouse Gas Reduction Taskforce. Thanks to Steve Bahr from Duke Energy, Randy Gary from Vectren Energy, Eli Yewdall from the International Council for Local Government Initiatives, Leah Snow from Indiana Department of Transportation, James Martin from Sycamore Ridge Landfill, Barry Collins from Bloomington City Public Works, and Joe Fish from Bloomington City Planning for providing data and insight. Adam Wason and Linda Thompson, along with the wider Environmental Commission and Commission on Sustainability provided guidance and feedback that improved this report.

## EXECUTIVE SUMMARY

As signatory to the U.S. Mayors Climate Agreement, the City of Bloomington committed to reducing its greenhouse gas emissions to 7% below 1990 levels by 2012. Achieving this goal requires an understanding of current, past, and future emissions levels. Employing software distributed by the International Council for Local Environmental Initiatives (ICLEI), the City of Bloomington Environmental Commission and the Commission on Sustainability collected energy consumption data from the cityôs Residential, Commercial, Industrial, Transportation, and Solid Waste sectors and calculated greenhouse gas emission levels for 1990, 2006, and 2012. Bloomingtonôs total greenhouse gas footprint for 2006 was 924,479 tons of $CO_2$ equivalent emissions. Transportation, Commercial, and Residential sectors represent the biggest targets for emissions reductions. The estimated 1990 emission level was 757,332 tons and the projected 2012 level will be 990,937 tons. Based on these numbers, the goal to reach the Mayors Climate Challenge of 7% below 1990 levels is 704,319 tons. Based on these projections, the City would have needed to reduce its greenhouse gas emissions by 220,160 tons from 2006 levels. Waiting until 2012 to take action will require reductions of 286,618 tons. A year by year breakdown of total emissions and the amount needed to reduce emissions to achieve the U.S. Mayors Climate Agreement is illustrated in Table 1. Clearly, the sooner that reduction strategies are implemented, the easier it will be to meet the 704,319-ton cap.

Table 1. Total emissions and amount needed to meet U.S. Mayors Climate Agreement by year (in tons of $CO_2$ equivalent)

| Year | Total | Needed Reduction |
|---|---|---|
| 1990 | 757,332 | 53,013 |
| 2006 | 924,479 | 220,160 |
| 2007 | 914,040 | 209,721 |
| 2008 | 928,512 | 224,193 |
| 2009 | 943,480 | 239,161 |
| 2010 | 958,872 | 254,553 |
| 2011 | 974,703 | 270,384 |
| 2012 | 990,937 | 286,618 |

Using the ICLEI software, this report lays out reduction strategies from increased public transportation, traffic and street light upgrades, compact fluorescent light bulb (CFL) replacement, and the Duke Energy GoGreen program. These reduction strategies result in emission reductions of 186,354 $CO_2$-equivalent tons, an insufficient level of reductions to meet the 704,319-ton cap, even had they been implemented starting in 2006. Nevertheless, this report provides a good illustration of the strategies that can help the community reduce its greenhouse gas footprint. The recommended reduction strategies represent a significant first cut in what will need to be a large-scale, concerted effort by public and private interests throughout Bloomington to fully meet Bloomingtonôs climate protection commitment.

## INTRODUCTION

On April 21, 2006, Bloomington Mayor Mark Kruzan signed the U.S. Mayors Climate Protection Agreement, committing Bloomington to reduce its greenhouse gas emissions to 7% below 1990 levels by the end of 2012. Reduction levels comply with the Kyoto Protocol, an international agreement that sets binding targets for reducing greenhouse gas emissions. Although 183 countries have ratified the Kyoto Protocol to date, the United States has not.[2] The U.S. Mayors Climate Protection Agreement was established to promote the Kyoto Protocolôs emissions reduction goals within the U.S.

Bloomington, along with the other 300 signing members of the Mayors Climate Agreement, realizes the dangers that elevated levels of greenhouse gases can have on the environment and society. One alarming result of increased greenhouse gases in our atmosphere is global warming. When sunlight strikes the Earthôs surface, some of it is re-radiated back toward space as infrared radiation (heat). Greenhouse gases (primarily carbon dioxide, methane, nitrous oxide and fluorocarbons[3]) absorb this infrared radiation and trap the heat in the atmosphere. Due to activities such as the burning of fossil fuels like coal and oil, humans have been steadily increasing the level of greenhouse gases in the atmosphere since the industrial age. As a result, the Earthôs atmosphere is trapping more heat, leading to global warming[4]. Some already observed or potential effects of global warming include severe, unpredictable weather, the melting of glaciers and polar icecaps and consequent rises in seawater levels, dramatic shifts of traditionally arid and/or humid regions, mass human and animal migrations, species extinctions, and shifts in agricultural output that could lead to substantial food shortages.[4,5]

Cities that take on the challenge of combating global warming by reducing greenhouse gas output will not only do their part in stemming a potentially devastating environmental catastrophe, but will also experience local, tangible benefits, including healthier homes and communities, and lower water and energy usage (leading to lower costs).[6]

In order for the City of Bloomington to move toward the U.S. Mayors Climate Protection Agreement goal, a baseline assessment of greenhouse gas emission levels coupled with practical and cost effective recommendations for reducing emissions is necessary. The aim of this report is to update and expand on preliminary emission level assessments and emission reduction recommendations developed by the City of Bloomington Environmental Commission in 2004[7,8]. This report uses the International Council for

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[2] http://unfccc.int/kyoto_protocol/items/2830.php

[3] 9http://www.eia.doe.gov/bookshelf/brochures/greenhouse/Chapter1.htm

[4] Intergovernmental Panel on Climate Change (IPCC). 2007. ñClimate Change 2007: Synthesis Report.ò Retrieved October 2008 from http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

[5] http://www.umich.edu/~gs265/society/greenhouse.htm

[6] http://www.greencommunitiesonline.org/green/benefits/

[7] Preliminary Assessment of Greenhouse Gas Emissions Associated with Activities in Bloomington, Indiana: Inventory and Trends. A Report by the City of Bloomington Environmental Commission, Bloomington, Indiana, July 2006. Prepared by Environmental Commission Intern Mike Steinhoff.

Local Environmental Initiativesô (ICLEI) Clean Air and Climate Protection (CACP) software. The ICLEI software is used to estimate 1990 and 2012 emissions levels in order to gauge Bloomingtonôs position with respect to Mayors Climate Agreement emissions reductions targets.

**ICLEI**

As part of the effort to reach the goals of the Mayors Climate Agreement, the City of Bloomington joined ICLEI in June 2008. ICLEI is an international association of over 800 local governments and governmental organizations working on sustainable development initiatives. One of ICLEIôs primary initiatives is addressing climate change at the local government level. The Cities for Climate Protection (CCP) campaign was created by ICLEI and municipal leaders in 1993 at the United Nations in New York. At this initial meeting, a declaration was adopted that called for the establishment of a worldwide movement of local governments to reduce greenhouse gas emissions, improve air quality, and enhance urban sustainability. This declaration became the CCP campaign.[9]

As a participant in the CCP campaign, the City of Bloomington commits to 5 milestones:

1. Conduct a baseline emissions inventory and forecast
2. Adopt an emissions reduction target for the forecast year
3. Develop a local action plan
4. Implement policies and measures
5. Monitor and verify results

The goal of this report is to achieve milestones 1, 2, and 3. The City can use this report to implement policies and monitor progress to reach the goals of the U.S. Mayors Climate Protection Agreement.

The primary benefits of membership in ICLEI and the CCP campaign are consistency and continuity. The CACP software is compliant with international standards and provides a simple, standardized way of acting to reduce greenhouse gas emissions that is used by numerous other cities committed to addressing climate change. Information is collected on the major sources of fossil fuel energy use in the city. Because there is a direct correlation between the amount of energy consumed and the amount of carbon emitted, the software can accurately calculate the amount of $CO_2$ emitted from each energy source by applying the correct emissions factor, or amount of $CO_2$ released per unit by that fuel source.[10] Greenhouse gases have different levels of heat retention. The CACP software converts all greenhouse gases to ñ$CO_2$-equivalentò emissions to allow

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[8] A Framework for Developing a Greenhouse Gas Reduction Plan for Bloomington, Indiana. A Report by the City of Bloomington Environmental Commission, Bloomington, Indiana July 2006. Prepared by Environmental Commission Intern Eric Roberts.

[9] http://www.iclei.org/index.php?id=800

[10] Pizer, William A. ñScope and Point of Regulation for Pricing Policies to Reduce Fossil-Fuel $CO_2$ Emissions.ò *Assessing U.S. Climate Policy Options*. Resources for the Future. 2007, pg. 69.

comparisons among emissions sectors. $CO_2$-equivalent is computed by multiplying the weight of the gas being measured (for example, methane) by its estimated greenhouse weight potential relative to $CO_2$.[11] Putting all greenhouse gas emissions in terms of $CO_2$ allows for direct comparison for all emissions and thus allows a calculation of total greenhouse gas footprint. Using this same software technology year to year will allow the City of Bloomington to conduct greenhouse gas inventories in coming years that are analyzing the same criteria and using the same assumptions as past inventories.

## COMPARISON TO METHODOLOGY OF PREVIOUS REPORT

This analysis is an update of the 2006 Environmental Commission report ñPreliminary Assessment of Greenhouse Gas Emissions Associated with Activities in Bloomington, Indiana: Inventory and Trendsò. The two reports look at the same types of data ï energy consumption, transportation, and solid waste disposal. The two analyses differ in two important ways. One is the way in which data is broken down to be analyzed. The 2006 report breaks down greenhouse gas contributors mainly by energy type - Electricity, Natural Gas, Transportation, and Solid Waste. This report, as recommended by ICLEI and endorsed by the United Nations Intergovernmental Panel on Climate Change (IPCC), breaks down contributions by sector ï Residential, Commercial, Industrial, Transportation, and Solid Waste. While these two approaches both look at the same types of energy consumption, the ICLEI approach allows analysis of energy trends by sector, helping to identify areas where consumption is increasing/decreasing as well as areas with the most consumption. This approach provides more information that can be helpful in creating effective reduction plans.

The reports also differ in the way data were collected. In 2005, Duke Energy changed the way it tracked electricity consumption in the city. Thus, it is impossible to directly compare the 2004 data used in the 2006 report to the 2006 data used in this report. The City is working to create long-term relationships with Duke Energy and Vectren Energy to ensure future data collection is consistent. Additionally, this report will be supplemented with documentation on how data were collected to facilitate consistency from year to year.

The Environmental Commissionôs 2006 analysis employed recommendations for greenhouse gas inventories outlined by the IPCC. Similarly, the CACP software is approved by the IPCC. The CACP software has the added advantage of being used by hundreds of other municipalities throughout the country, making Bloomingtonôs analysis consistent with similar inventories in other cities. As noted above, the way consumption is broken down is different between the 2006 Environmental Commission Report and the CACP analysis, making a direct comparison between sectors impossible. However, because the same energy consumption areas are measured, we can compare the aggregate emission levels of the two reports. The total greenhouse gas footprint reported in the 2006 report for the year 2004 was 893,293 tons of $CO_2$-equivalent emissions. Using the

[11] ñEmissions of Greenhouse Gases Report.ò Energy Information Administration. http://www.eia.doe.gov/oiaf/1605/ggrpt/, 2001

data collected for this report in the CACP software, a comparable figure of 851,787 tons of $CO_2$-equivalent emissions is calculated for the year 2004. These totals are illustrated in Figure 1. The similarity in the two footprints shows that emissions footprint calculations are robust to some variation in the methods of analysis. The relatively small difference can be attributed to differences in information available as well as assumptions, for example concerning technology, used in the 2006 analysis versus the current analysis.

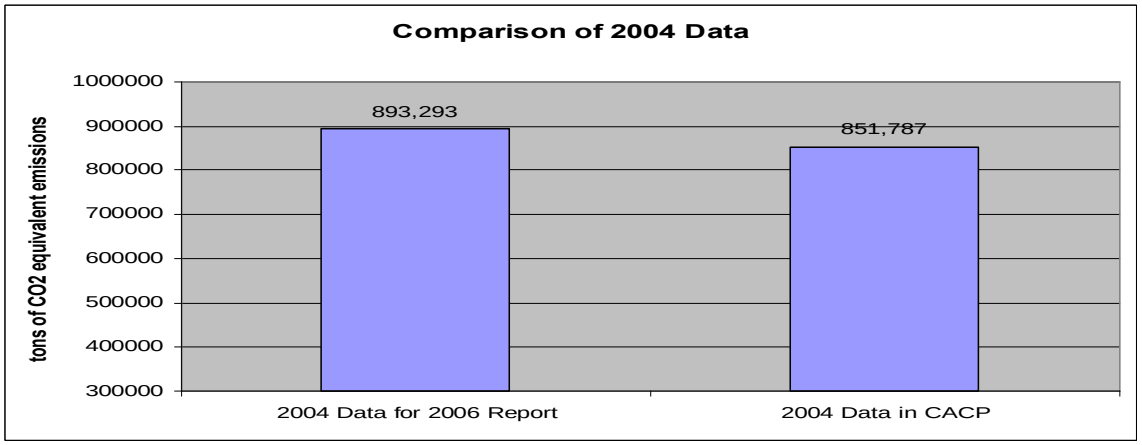


Figure 1. Comparison of 2004 and 2006 Emissions Data.

## SECTOR ANALYSIS

In this section, the current greenhouse gas footprint for each of the Residential, Commercial, Industrial, Transportation and Solid Waste sectors is analyzed. In each case, how the sector contributes to greenhouse gas levels and how the relevant data was collected and analyzed is provided.

In Bloomington, the primary sources of greenhouse gas emissions for the Residential, Commercial, and Industrial sectors are electricity and natural gas. Electricity is used for cooling and lighting our homes and businesses and powering our appliances and electronics. In the future, electricity may also power our cars. Indianaôs primary source of electrical generation is coal burning. Combusting one ton of coal generates about 5,720 pounds of carbon dioxide.[12] Ninety-five percent of Indianaôs electricity is generated by coal, while 5% is generated by natural gas.[13] Currently, renewable energy contributes only a negligible amount of electricity. Duke Energy provided all data regarding Bloomingtonôs consumption of electricity for 2006. Electricity is usually measured in kilowatt hours (kWh), the amount of kilowatts (power) used over a 60-minute time period.

While natural gas is responsible for some electricity in Bloomington, its primary use is in heating. While sometimes labeled as ñclean burningò, natural gas does emit carbon

[12] http://www.eia.doe.gov/cneaf/coal/quarterly/co2_article/co2.html
[13] City of Bloomington Environmental Quality Indicators Report. http://bloomington.in.gov/sections/viewSection.php?section_id=499

dioxide and methane. However, when compared to burning coal for heat, natural gas is far less problematic in terms of air pollution and climate change, producing less particulate matter, smog and approximately 45% less $CO_2$. Vectren Energy, the cityôs provider of natural gas, supplied all natural gas data used in this report. While the original data was provided in therms, these values were converted to kWh for comparison to other sectors.

***Residential Sector***

This sector encompasses all private residences within Bloomington. Owned, rented, and vacant private residences are included in the inventory.

In 2006, natural gas accounted for 59.71% of total kWh consumed in the Bloomington residential sector, while coal accounted for the remaining 40.29%. The total amount of coal consumed (95% of electricity production) was 292,424,591 kWh. Also that year, 433,462,717 kWh of natural gas was consumed (heating plus 5% of electricity generation). Applying the emission factors for electricity and natural gas embedded in the ICLEI software to these consumption levels and aggregating yields 199,720 tons of $CO_2$-equivalent emissions from the residential sector.

***Commercial Sector***

This sector consists of business establishments such as hotels, restaurants and bars, wholesale businesses, retail stores and laundries. Any business not engaged in transportation, manufacturing, or other types of industrial activities falls under the umbrella of the commercial sector.

In the Bloomington commercial sector in 2006, coal accounted for 76.92% of total kWh consumed, while natural gas accounted for the remaining 23.08%. Coal consumption in 2006 was 754,031,310 kWh. Natural gas consumption was 226,304,514 kWh. Aggregating the emission factors for electricity and natural gas embedded in the ICLEI software to these consumption levels and aggregating yields 327,027 tons of $CO_2$-equivalent emissions from the commercial sector. Commercial businesses were the single largest contributing sector to Bloomingtonôs carbon footprint in 2006.

***Industrial Sector***

Industrial energy consumption comes from manufacturing, construction, and agriculture and forestry. In the Bloomington industrial sector in 2006, coal accounted for 98.01% of total kWh consumed, while natural gas accounted for the remaining 1.99%. Coal consumption was 165,743,024 kWh in 2006. Natural gas consumption was 3,372,831. Applying the emission factors for electricity and natural gas embedded in the ICLEI software to these consumption levels and aggregating the results yields 62,106 tons of $CO_2$-equivalent emissions from the industrial sector.

***Transportation Sector***

Greenhouse gas emissions from transportation come from private, public, and city fleet transportation vehicles. Greenhouse gas emissions from transportation can be calculated

either by the total amount of vehicle miles traveled (VMT) within the city or by the amount of fuel consumed. VMT is calculated by traffic counts, while fuel consumed is calculated by the amount of fuel purchased within the city limits of Bloomington. Generally, vehicle miles traveled is preferable to fuel consumed, because it is impossible to know how much fuel that is purchased in Bloomington is consumed in Bloomington, as opposed to purchased in Bloomington and consumed elsewhere. An additional problem with the amount of fuel consumed is that fuel can be purchased elsewhere and consumed in Bloomington.[14]

Although vehicle miles traveled is thought of as the best measure of transportation greenhouse gas emissions, it results in much more ambiguity in analysis than for other sectors. This stems from the fact that it is nearly impossible to track all vehicle movement within the city limits. The Bloomington/Monroe County Municipal Planning Organization, Indiana Department of Transportation, and Federal Highway Administration track and project vehicle miles traveled by collecting vehicle flow at designated counting stations located on U.S. Highway 37 and the State Highway 45/46 bypass over a 48 hour period. These flow counts are then applied to the length of registered roadway in the city and the projected daily use for each road type.[15] Daily VMT in Bloomington for 2006 is estimated at 1,381,000 miles.[16]

To know the annual vehicle miles traveled, daily VMT must be multiplied by an annual rate. Because it is assumed that the daily VMT calculations are peak travel estimates,[17] simply multiplying by 365 to calculate annual VMT would lead to inflated calculations. Thus, the daily rate is multiplied by 323[18] to factor in fluctuation of traffic flows due to population changes caused by the Indiana University calendar (assumption: traffic flows go down when IU is not in session). By this method, the annual VMT for Bloomington in 2006 is calculated at 446,021,570 miles. While there are a number of assumptions built into VMT analysis, it does provide the best available method of estimating travel within the city of Bloomington. More importantly, applying the same criteria year-to-year will give a consistent analysis of the trends in VMT.

To calculate greenhouse gas emissions from transportation, the total VMT is applied to the percentage of each fuel type (gasoline, diesel, biofuels, etc.) and vehicle type (compact cars, regular size cars, compact trucks, full size trucks, etc.) that make up the vehicle population in Bloomington. Because this information is not tracked at the local or state level, national averages imbedded in the CACP software are applied. Applying the annual VMT data to the percentages for fuel type and vehicle type and their

[14] ñClean Air and Climate Protection Software.ò ICLEI. June 2003. Pg. 46.
[15] Email correspondence with Leah Snow of Indiana Department of Transportation 7/8/2008.
[16] Highway Statistics 2006. U.S. Department of Transportation, Federal Highway Administration. Section V: Roadway Extent, Characteristics and Performance.
http://www.fhwa.dot.gov/policy/ohim/hs06/roadway_extent.htm
[17] Personal correspondence with Planning Department Transportation Manager Scott Robinson.
[18] This number is calculated multiplying daily VMT times the weighted average of population based on the proportion of the year Indiana University semesters and summer school are in session. It is assumed that 25% of IU students are in Bloomington year round, while the rest leave while school is not in session.

corresponding emission factors yields carbon-equivalent greenhouse gas emissions of 291,317 $CO_2$-equivalent tons.

***Solid Waste Sector***

The primary source of greenhouse gas emissions associated with solid waste disposal comes from the release of methane caused by the anaerobic (oxygen-free) breakdown of organic material in landfills. Methane is a greenhouse gas that captures heat 21 times more powerfully than carbon dioxide.[19] Thus, even low levels of methane emissions can have major impacts on greenhouse gas levels and global warming. For this section, methane levels are converted to $CO_2$-equivalent levels so they can be compared to emissions associated with other sectors.

To calculate the $CO_2$-equivalent emissions from Bloomington solid waste disposal, the CACP software takes the amount of waste generated in a particular year and the composition of that waste to find the amount of the waste that contains organic material and thus emits methane from landfills. Information on amount of solid waste comes from the Indiana Department of Environmental Management Solid Waste Facilities Annual Report. This report lists the tons of waste disposed of in Indiana by county of origin.[20] This information is not tracked at the city level, so the total amount of waste disposed of in Bloomington is found by finding the proportion of the Monroe County population that resides in Bloomington and applying that proportion to the amount of waste generated in Monroe County. This assumes that City of Bloomington residents create the same amount of solid waste as county residents. In 2006, 146,126 tons of solid waste was generated in Monroe County.[21] In the same year 58.74% of the Monroe County population resided within the City of Bloomington[22]. Thus, 85,829 tons of garbage was estimated to be generated in Bloomington in 2006. Information on composition of waste is not tracked at the local or state level, so national EPA averages are applied. The EPA 2006 average organic waste proportions are 33.9% paper, 12.9% yard trimmings, 12.4% food scraps, and 5.5% wood/textiles.[23] Of course, waste composition can vary widely depending on local disposal methods. For instance, Bloomingtonôs yard trimmings percentage is most likely lower than the national average due to the cityôs curb-side yard waste pick-up service, which composts yard waste in aboveground piles, thus avoiding methane production. Thus, additional information would be helpful to make more accurate estimates of greenhouse gas levels generated from Bloomington solid waste disposal. Applying the estimated tons of garbage generated in Bloomington and EPAôs average composition of waste leads to 44,309 tons of $CO_2$-equivalent greenhouse gas emissions for 2006.

[19] Methane. U.S. Environmental Protection Agency. http://www.epa.gov/methane/
[20] 2006 Indiana Solid Waste Facility Report. Indiana Department of Environmental Management. Pg. 12.
[21] Ibid.
[22] U.S. Census Bureau.
[23] Municipal Solid Waste Basic Information. U.S. Environmental Protection Agency. http://www.epa.gov/msw/facts.htm

***Totals***

Totaling emissions from the five sectors together, the City of Bloomingtonôs 2006 carbon footprint is 924,479 tons of $CO_2$-equivalent emissions. The Commercial sector contributed the most greenhouse gases, 34% of the total, followed by transportation (32%), residential (22%), industrial (7%), and solid waste (5%) (Figure 2).

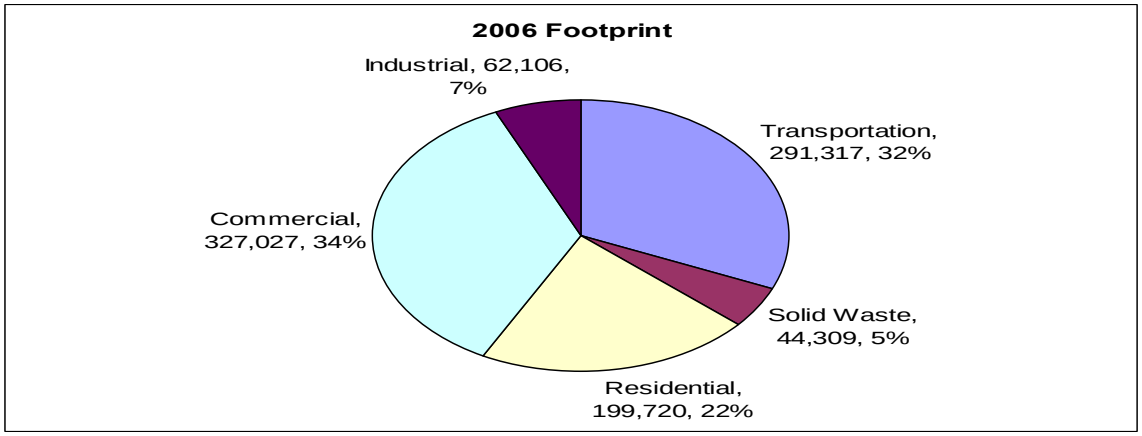


Figure 2. Bloomington total $CO_2$ footprint for 2006.

**PROJECTIONS**

To assess how the City of Bloomingtonôs current carbon footprint compares to the U.S. Mayors Climate Protection Agreement emissions reduction target, data on 1990 and 2012 $CO_2$-equivalent greenhouse gas emissions are needed. Because there is incomplete data for 1990, and 2012 data has not yet been generated, it is necessary to make projections for these levels. To project these levels, the CACP software takes the current footprint and applies growth rate estimates for each sector. Different growth rates are applied to different sectors, using sector-appropriate indicators that help to project changes in consumption that affect $CO_2$-equivalent greenhouse gas levels. All growth indicators are suggested by ICLEI as proxies to show growth-related trends. The methodology will be explained for each sector below. Growth rate estimates for each sector are back projected from 2006 to yield 1990 estimates and forward projected from 2006 to yield 2012 estimates. The 1990 and 2012 emissions estimates for each sector are then aggregated and compared to the current footprint to gain a sense of the reduction in emissions the City needs in order to meet levels required by the Mayors Climate Agreement.

***Residential***

Residential $CO_2$-equivalent greenhouse gas levels are projected using the average annual rate of homes added to, or subtracted from, the City of Bloomington. The assumption used for this assessment is that homes added (through new construction or annexation) or subtracted (through demolition) are the driving force for electricity and natural gas consumption changes in the residential sector. The net number of homes in the City increased from 20,983 in 1990 to 26,468 in 2000.[24] Reliable projections after the 2000 census are unavailable. Using the 1990 to 2000 trend, the annual rate of increase is

[24] 2000 U.S. Census. United States Census Bureau.

2.61%. The CACP software uses this rate of change to back project 1990 levels and forward project 2012 residential emissions levels based on the 2006 footprint (Figure 3).

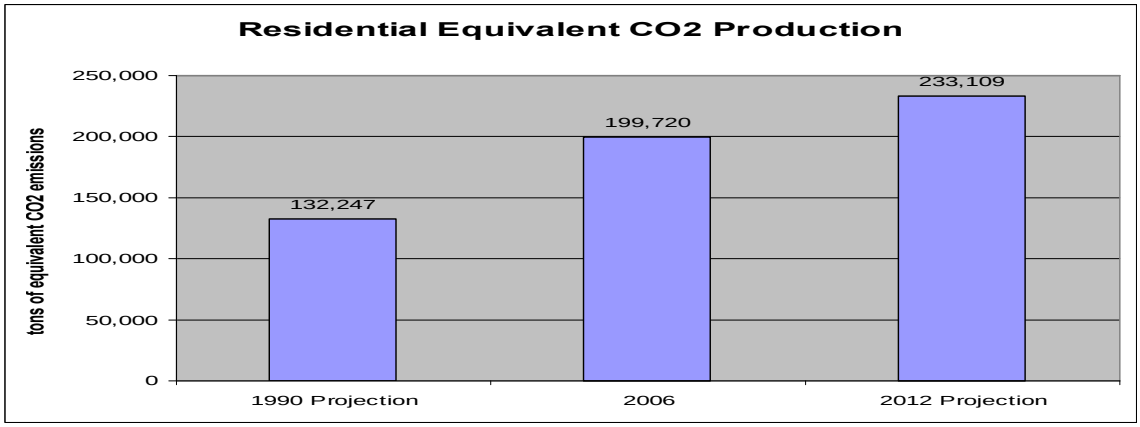


Figure 3. Residential $CO_2$-equivalent production for the years 1990, 2006, and 2012.

## ***Commercial***

Commercial $CO_2$-equivalent greenhouse gas levels are projected using total employment trends in the commercial sector from 1990 to 2006. The assumption used for this assessment is that there is a correlation between number of employees and the total size and energy consumption of facilities. The size of facilities has the greatest impact on changes in energy consumption. Employment information was collected from the U.S. Bureau of Labor Statistics. During this time Bloomingtonôs commercial sector grew at an annual rate of 2.27%.[25] As with the residential sector, the CACP software uses this rate of change to project 1990 and 2012 levels (Figure 4).

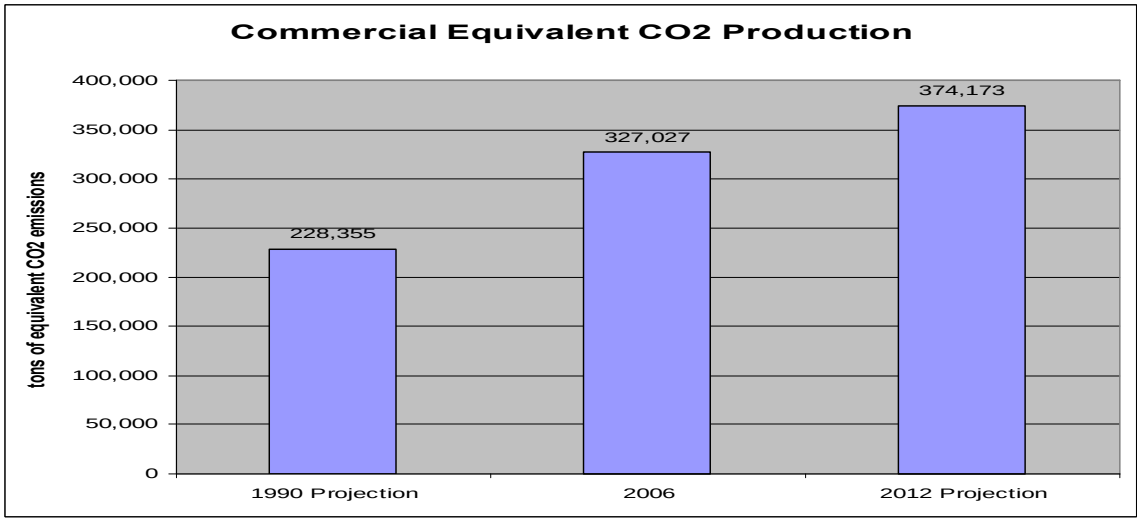


Figure 4. Commercial $CO_2$-equivalent production for the years 1990, 2006, and 2012.

## ***Industrial***

[25] ñState and Area Employment, Hours, and Earnings.ò Bureau of Labor Statistics. http://data.bls.gov/PDQ/outside.jsp?survey=sm

Industrial $CO_2$-equivalent greenhouse gas levels are projected using employment trends from 1990 to 2006. Using Bureau of Labor Statistics employment statistics, the industrial sector employment grew at a rate of 0.50% per year over this time period, yielding back and forward projections as illustrated in Figure 5.

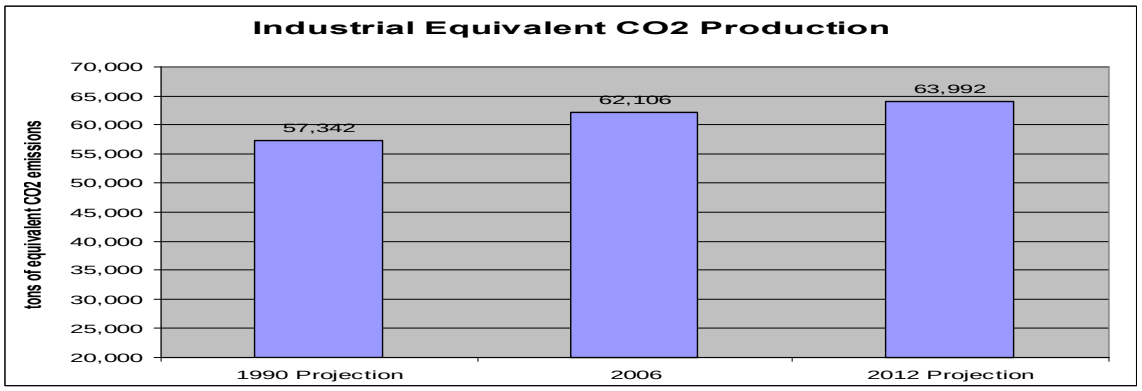


Figure 5. Industrial $CO_2$-equivalent production for the years 1990, 2006, and 2012.

***Transportation***

Transportation $CO_2$-equivalent greenhouse gas levels are projected using average annual population growth in the City. The assumption used for this assessment is that demand from population increases is the most significant factor in increases or decreases in transportation consumption. The average annual rate of increase is projected using 1990 and 2000 census data, as well as post-2000 population projections from the U.S. Census Bureau. This annual rate of increase is 0.89%.[26] The CACP software uses this rate of increase as well as known (for 1990) and assumed (for 2012) changes in technology, most notably changes in miles-per-gallon standards, to project $CO_2$-equivalent greenhouse gas emission levels (Figure 6).

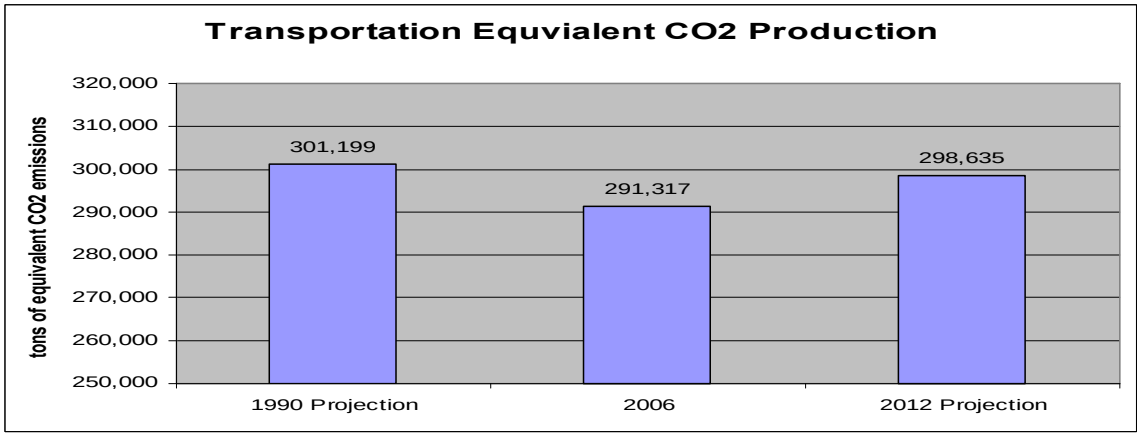


Figure 6. Transportation $CO_2$-equivalent production for the years 1990, 2006, and 2012.

[26] U.S. Census Bureau.

It is important to note that even though total VMT rose from 1990 to 2006 (Figure 7) there is a drop in $CO_2$-equivalent production from 1990 to 2006 due to changes in technology.

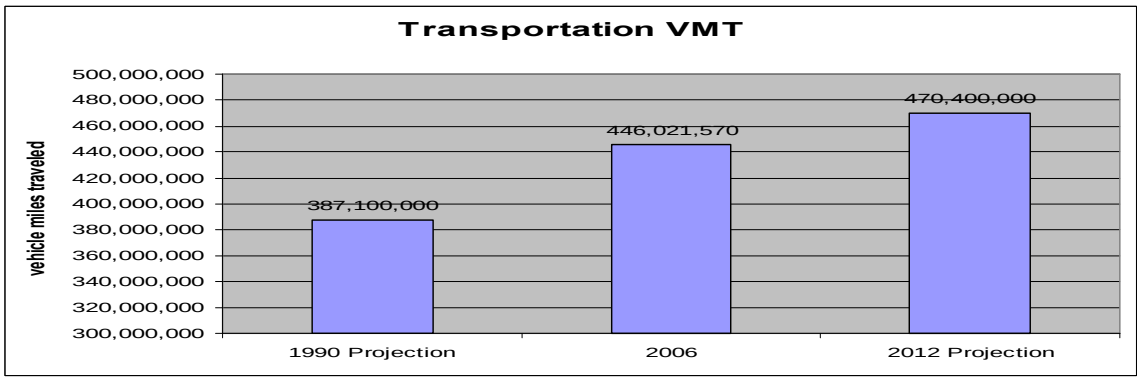


Figure 7. Transportation VMT

## ***Solid Waste***

As for the transportation sector, solid waste $CO_2$-equivalent greenhouse gas levels are projected using average annual population growth in the City. Like transportation, the assumption used for this assessment is that average waste production from population increases is the most significant factor in increases or decreases in the amount of waste produced. It is also important to note that the 1990 $CO_2$-equivalent level is not a projection because data on solid waste disposal for that year was available from the Indiana Department of Environmental Management. Projections for 2012 are made using the same 0.89% annual rate of population increase as used for the transportation sector. Emissions data for solid waste are presented in Figure 8.

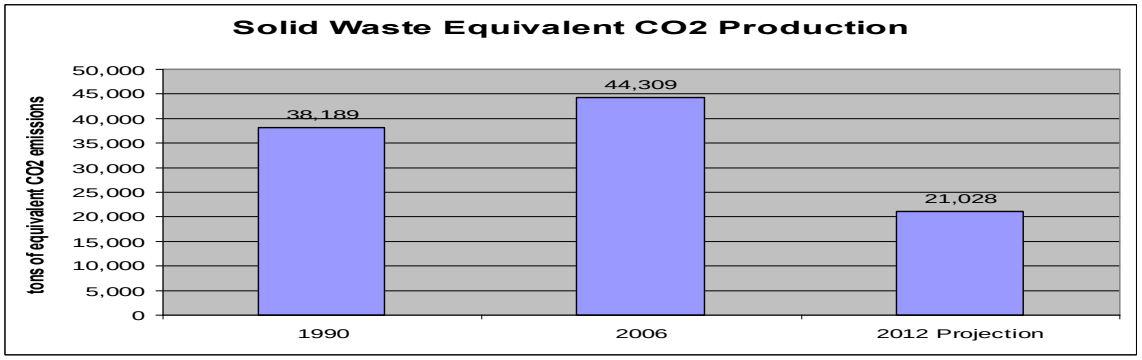


Figure 8. Solid waste $CO_2$-equivalent production for the years 1990, 2006, and 2012.

It is important to note that the 2012 projection is a significant decrease from 1990 and 2006 emissions because of methane capture technology installed at the Sycamore Ridge Landfill (the landfill where the vast majority of Bloomington solid waste is currently disposed) during the summer of 2008. This technology captures an estimated 55% of methane emissions from the landfill. This methane is then sold as energy to an adjoining

brick plant.[27] Thus, like the transportation sector, even though solid waste disposal is projected to increase (Figure 9) due to population increases; the $CO_2$-equivalent production is projected to decrease.

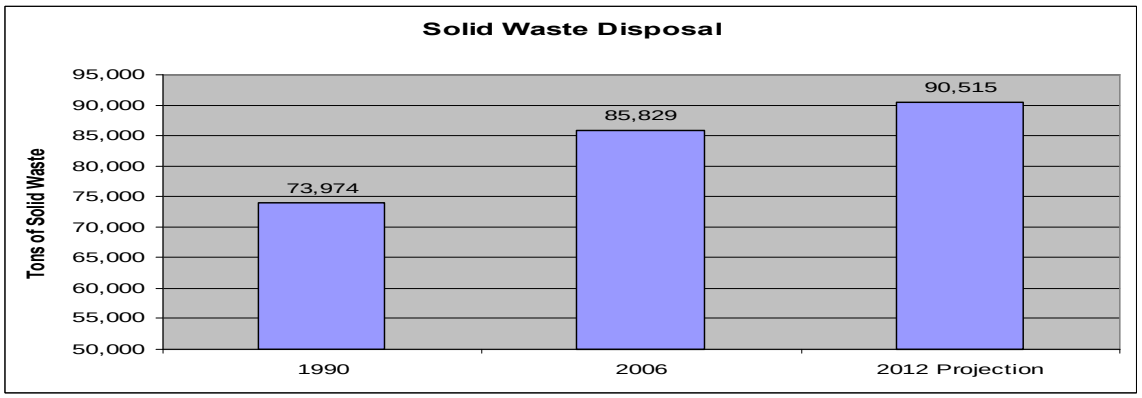


Figure 9. Solid waste disposal for the years 1990, 2006, and 2012.

## ***Totals***

Aggregating each sector, the 1990, 2006, and 2012 emissions levels are 757,332, 924,479 and 990,937 tons of $CO_2$-equivalent emissions (Figure 10). A 7% reduction in 1990 levels yields 704,319 tons of $CO_2$-equivalent emissions as the Cityôs goal for 2012. Given the 2006 footprint of 924,479 tons, the city would have needed to reduce by 220,160 tons (36,693 per year) from the 2006 carbon footprint and will need to reduce by 286,618 tons (47,770 tons per year) below the 2012 projections. Year totals compared to the overall goal are illustrated in Figure 10, while the amount of reduction required to reach the goal is illustrated in Figure 11.

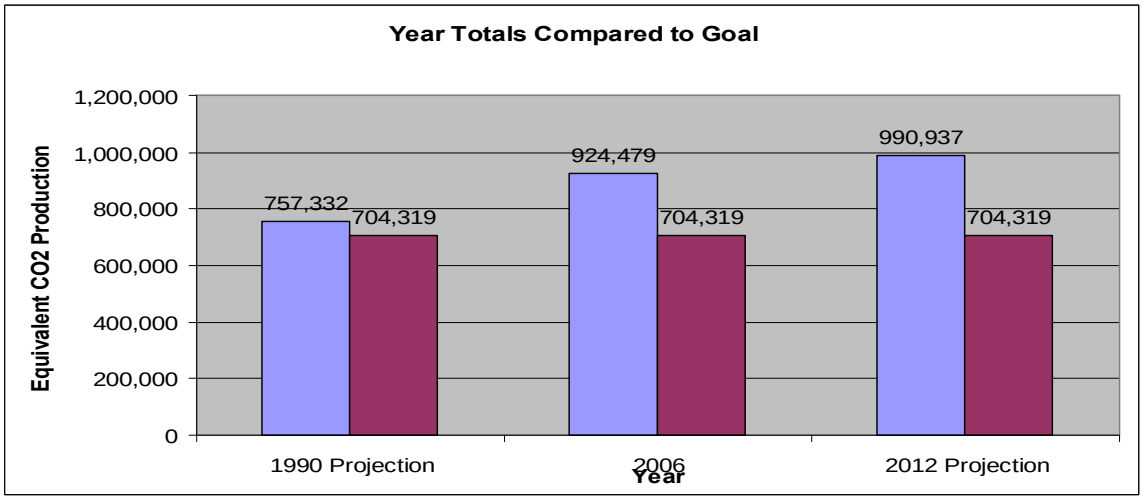


Figure 10. $CO_2$ emissions/projections compared to Mayors Climate Agreement goal.

[27] Personal communication with James Martin, Sycamore Ridge Landfill Engineer. July 16, 2008.

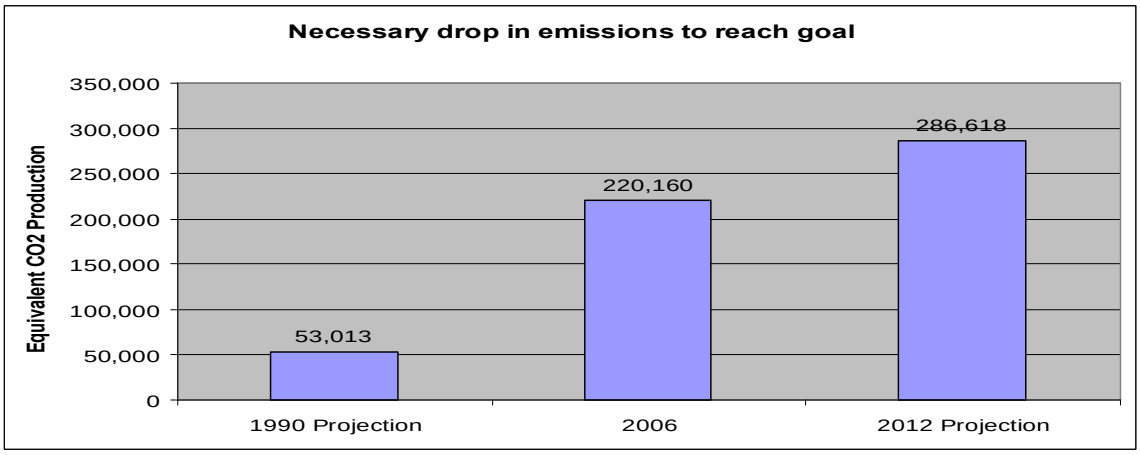

Figure 11. Emission reduction necessary to reach Mayors Climate Agreement goal.

## RECOMMENDATIONS

From this analysis, the largest contributors to greenhouse gases in Bloomington are the Commercial, Transportation, and Residential sectors. Thus, recommendations for reductions in greenhouse gases focus on these contributors. The recommendations in this section were developed from researching other citiesô best practices and emissions reduction policies and from a previous City of Bloomington report.[8] The ICLEI software was then employed with the information from the first part of this report to quantify a number of reduction strategies. The ICLEI software uses reductions in demand and pre-set coefficients, such as the fuel efficiency of vehicles, to help determine the total amount of $CO_2$-equivalent emissions reduced by implementing a given reduction strategy. The price savings of the proposed reduction strategies can also be tracked. Again, because the CACP software is easy to use and is consistent from year to year, it will be easy to track progress on these strategies in the future.

Five general strategies emerged as cost effective ways to achieve substantial reductions in the Commercial, Transportation, and Residential sectors: light-bulb switching, promotion of more energy-efficient buildings, pursuit of renewable energy sources, promotion of alternative transportation, and limiting vehicle emissions. Outlined below are the general assumptions and mathematics used for analysis along with the resulting emissions reduction (and where available, price savings) that could be accomplished. Developing these recommendations required some broad generalizations and assumptions and are thus estimates subject to change. Because strategies for the Commercial and Residential sectors are complementary, these will be discussed together, following a discussion of Transportation strategies.

As noted earlier the total amount of $CO_2$-equivalent emissions needed to reach the U.S. Mayors Climate Protection Agreement goal of 7% below 1990 emissions by 2012 is 286,618 tons reduced from the 2012 baseline. Assuming all of the following strategies are implemented and completed by 2012, the aggregate reduction is still only around 185,000 tons. Clearly, a more aggressive and comprehensive plan, in which the entire City and community is involved, will be necessary to achieve the goals outlined by the

U.S. Mayors Climate Protection Agreement and City Council Resolution 06-05. However, these recommendations represent an important first step in the overall process by identifying key initial areas of focus.

## TRANSPORTATION

### *Alternative Transportation*

The first strategy recommended is that of a large switch to alternative transportation from personal vehicle use within the community. There is already evidence of increased use of alternative transportation in Bloomington. First, use of the Bloomington Transit bus system has increased 38.6% from 2.02 million riders in 2004 to a projected 2.80 million in 2008.[28] It can be assumed that this increased ridership offsets private vehicle miles traveled, but it is beyond the scope of this report to know the proportion of this offset. It can further be assumed that private VMT will be offset by the B-Line bike trail, although again, knowing how much private VMT will be offset is difficult. Bicycle travel is an ideal form of transportation, as it produces essentially no greenhouse gas emissions.

In order to gain a sense of the potential impact alternative transportation can have on reducing greenhouse gas emissions, a set of assumptions were used to project emissions reductions. From the Transportation SECTOR ANALYSIS above, current VMT projections are 6,150 per person per year. Letôs make the conservative assumption that even just 2.5%,[29] or 150 of this VMT, can be offset by alternative means of transportation. Using the projected city population of 76,493 in 2012, alternative transportation could then lead to a $CO_2$-equivalent emissions reduction of 3,685 tons. Other reductions under this scenario include 6,246 pounds of NOx, 618 pounds of SOx, 377,363 pounds of CO, 35,468 pounds of Volatile Organic Compounds (VOCs), and 229 pounds of PM10 (larger particulate matter). To illustrate the impact of further reduction in private VMT, offsets of 5%, 7.5%, 10% and the corresponding $CO_2$-equivalent offset are illustrated in Table 2.

Table 2. Percentage conversion from private VMT to alternative transportation and the corresponding carbon offset (in tons)

| Percentage Offset | Carbon Offset (tons) |
|---|---|
| 2.50% | 3685 |
| 5.00% | 7370 |
| 7.50% | 11055 |
| 10.00% | 14740 |

[28] Email correspondence with Bloomington Public Transportation Corporation General Manager Lew May. 12/12/2008.

[29] The City of Portland, OR projects that 4% of non-work VMT has been offset by recent alternative transportation measures.
ñBehavior Change Program Research.ò Empowerment Institute.
http://www.empowermentinstitute.net/files/VMT_study.html

***Limiting Vehicle Emissions***

Transportation greenhouse gas emissions can also be reduced by limiting the amount of fuel consumed by vehicles. This can be achieved by promoting more efficient vehicles (e.g. hybrids) and/or converting to fuels that have lower per unit greenhouse gas emissions than gasoline. It is recommended that the city convert its automobile fleet to reflect these more efficient technologies.

For example, for every 1,000 miles traveled, up to one ton less $CO_2$-equivalent emissions could be emitted by switching from gasoline to electricity driven vehicles, such as the Global Electric Motorcar (GEM). It is estimated that converting from traditional gasoline vehicles to electric vehicles can reduce greenhouse gas emissions by more than 25%.[30] Using this technology has the added benefit of substantial cost savings for the city. Table 3 provides example cost savings per year from a GEM car, one of which the City of Bloomington already owns. Cost estimates are based on current electricity, average weekly usage of Bloomingtonôs GEM car, average miles per gallon of conventional gasoline vehicles, and current cost of gasoline. A four passenger GEM car is priced starting at $9,695.

Table 3. Cost savings estimated from GEM car website (http://www.gemcar.com/) given inputs of electricity and gasoline cost.

| | **Compact Car** | **Mid-size** | **SUV/Truck** |
|---|---|---|---|
| Cost of electricity ($/kWh) | 0.09 | 0.09 | 0.09 |
| Average weekly mileage | 100 | 100 | 100 |
| Miles per gallon | 27 | 23 | 14 |
| Cost of gasoline ($) | 1.90 | 1.90 | 1.90 |
| ***Savings with GEM car ($/year)*** | ***272.33*** | ***335.97*** | ***612.11*** |

**ENERGY CONSUMPTION**

The other major contributing sectors of greenhouse gases in Bloomington ï Residential and Commercial ï can be addressed through measures aimed at reducing the amount of fossil fuel energy each of these sectors consumes. The major contributors to greenhouse gas emissions in both of these sectors are electricity and heat production. Outlined below are measures the city can take to reduce these consumption levels.

***Light Bulb Switching***

The switch from regular incandescent bulbs to compact fluorescent light (CFL) bulbs is one of the most effective and easy ways to reduce $CO_2$-equivalent emissions. The assumptions here are that 100 watt incandescent bulbs run for 10,000 hours and use 1,000 kWh, and that a CFL bulb of 23 watts (equivalent lighting) runs for 10,000 hours and uses 230 kWh, the actual energy savings over 10,000 hours (approximate lifetime of CFL) equals 770 kWh, and that the price of residential electricity is $0.0966 per kWh. Each 100 watt incandescent bulb that is replaced with an equivalently lighting 23 watt

[30] Wang, Michael Q. ñFuel-Cycle Greenhouse Gas Emissions Impacts of Alternative Transportation Fuels and Advanced Vehicle Technologies.ò Transportation Research Record. Vol. 1664, 1999. Pg. 9-17

CFL thus results in 1 ton of $CO_2$-equivalent emissions reduction. Other reductions include 3 pounds of NOx, 6 pounds of SOx, and $74 of savings on electrical bills and incandescent bulb purchases for every 100 watt incandescent to 23 watt CFL conversion. It is also important to note that the lifetime of each CFL bulb is 15 times that of a corresponding incandescent bulb, further enhancing the energy savings.

In 2007, the City of Bloomington ran a successful ñChange a Light, Change the Worldò CFL exchange program.[31] According to the government program ENERGYSTAR, which the city uses to track progress on the ñChange a Light, Change the Worldò campaign, 33,665 CFL bulbs have been sold in the Bloomington Metropolitan Statistical Area as of the first quarter of 2007.[32] If all of these bulbs have been used in Bloomington to replace 100 watt incandescent light bulbs, then 33,665 tons of greenhouse gas emissions through light bulb switching will be achieved over the lifetime of the CFL bulbs.

The practice of switching from incandescent to CFL bulbs can continue to reduce greenhouse gas emissions in the city. Using the projected 2006 population of Bloomington, if one incandescent bulb is replaced with a CFL bulb by each resident each year in 2009, 2010, and 2011, reductions will be: 179,096 tons of $CO_2$-equivalent emissions, 567,359 pounds of NOx, 1,357,091 pounds of SOx, 49,116 pounds of CO, 5,417 pounds of Volatile Organic Compounds (VOCs), and 35,292 pounds of PM10 (larger particulate matter), with a potential aggregate dollar savings of $16,185,226. Furthermore, if the business and commercial sector could be encouraged to switch to CFL bulbs, the reduction of $CO_2$-equivalent emissions could be much higher.

An important caution concerning CFL bulbs is proper disposal. CFLs contain high levels of mercury, so should not be thrown away and put into landfills, where the bulbs can be broken and the mercury emitted into the environment. Rather, CFL bulbs need to be recycled and the mercury reused. The Cityôs ñChange a Light, Change the Worldò campaign has been proactive in educating citizens about why and how to recycle CFLs[33], and such efforts should continue.

Similarly, light bulbs used by the city for traffic and street lights can be switched to improve energy efficiency. The city has already successfully switched all 818 incandescent light bulbs in traffic lights at 76 intersections to Light Emitting Diodes (LEDs), resulting in 787 tons/year of $CO_2$-equivalent emissions not emitted. The assumptions behind this calculation are that incandescent lights use 1000 kWh/year and LEDs are 90% more efficient and thus only use 100 kWh/year. This results in savings of 900 kWh/year per light and a total kWh saved per year of 818 lights * 900 kWh/light = 736,200 kWh/year. Other reductions include 2,493 pounds of NOx, 5,963 pounds of SOx, 216 pounds of CO, 24 pounds of Volatile Organic Compounds (VOCs), and 155

[31] http://bloomington.in.gov/documents/viewDocument.php?document_id=2778
[32] www.**energystar**.gov/ia/partners/reps/pt_reps_res_retail/files/CFL_Sales_by_State_and_**MSA**120607.xls
[33] ñChange a Light: Bloomington.ò
http://bloomington.in.gov/media/media/image/png/2412.png

pounds of PM10 (larger particulate matter). LED bulbs are even more efficient than CFL bulbs and also do not have the mercury issue associated with CFLs, and thus are an attractive future option for residential use. Currently the technology is too expensive to be effectively used in the residential market, but certainly could play a role in future energy consumption reductions.

Replacing street lights in the city could save an additional 2,230 tons/year of $CO_2$-equivalent emissions, 7,066 pounds of NOx, 16,901 pounds of SOx, 612 pounds of CO, and 67 pounds of VOCs. These calculations are based on a total of 3,133 streetlights in Bloomington, yielding a total electricity consumption of about 200,000 kWh/month, or 2,400,000 kWh/year, such that each light currently uses about 766 kWh/year (2,400,000 kWh/year)/(3,133 lights). LED bulbs only use 100 kWh/light/year, resulting in savings of 666 kWh/light/year (3,133 lights * 666 kWh/light/year = 2,086,578 kWh/year).

***Green Building Legislation and Outreach***

Another way for Bloomington to decrease energy consumption is to build and retrofit buildings to use energy more efficiently. Based on a draft green building ordinance prepared by the Environmental Commission in 2007, the City Council is considering an amendment to Title 2 of the Bloomington Municipal Code, adding Chapter 2.29 entitled ñGreen Building Programò.

> The purpose of the program is to: further the Cityôs commitment to environmental, economic and social stewardship; yield cost savings to City taxpayers through reduced operating costs; provide healthy work environments for staff and visitors; reduce local greenhouse gas emissions and prepare for a coming period of reduced supply of oil and natural gas.[34]

The ordinance states that compared to conventional buildings, green buildings consume 30-50% less energy and reduce carbon dioxide emissions by 39%.[35] The ordinance applies to all new buildings occupied by the City of Bloomington, as well as major renovations and minor renovations to city-owned buildings. The Public Works, Utilities, and Parks and Recreations Departments are currently compiling data on average monthly energy consumption.[36] This audit was initiated in January 2009. At the completion of this audit it can be determined how much energy can be conserved by switching to ñGreen Buildingò standards.

Clearly, promoting green building within the Residential, Commercial, and Industrial sectors can result in even greater reductions in Bloomingtonôs energy consumption. In 2007, the Environmental Commission worked with Assistant Economic Development Director Adam Wason and the Bloomington Commission on Sustainability to develop a green building website for the city of Bloomington and an accompanying green building overview pamphlet. The website is hosted on the Planning Departmentôs webpage at

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[34] Ordinance 08-__ To Amend Title 2 of the Bloomington Municipal Code Entitled ñAdministration and Personnelò (Adding Chapter 2.29 Entitled ñGreen Building Programò).
[35] Ibid.
[36] Email correspondence with City of Bloomington Department of Public Works Facilities Management Coordinator Barry Collins. 1/13/2009.

www.bloomington.in.gov/greenbuild/. During their work, the committee sought input from the Monroe County Building and Planning Departments and various local experts and citizens, holding two public meetings for the latter purpose. We recommend continued development of these outreach efforts.

***Renewable Energy***

Renewable energy is generated from natural resources such as sunlight and wind. This energy can be transmitted to the electricity grid and used to offset energy production by fossil fuels such as coal and natural gas, which contribute to greenhouse gas emissions. The more renewable energy that is transmitted to the grid, the less fossil fuel energy is necessary, leading to reduced greenhouse gas emissions.

There are several actions Bloomington could take, both at the individual and city-wide level, to increase the use of renewable energy. At the level of individuals, one option in Bloomington is the purchase of solar panels. Individuals can purchase solar panels and install them on the roof of their home or elsewhere on their property, providing electricity to the house. Any additional electricity that is needed can be bought from a conventional electricity provider. Through Duke Energyôs net metering program, there is also opportunity to sell any excess electricity to the electricity grid.[37] Other individual renewable energy opportunities include south-facing windows for passive solar space heating and solar water heaters for solar hot water heating; both of these options offset conventional heat consumption. Another individual opportunity to increase consumption of renewable energy is through purchasing renewable energy credits. Currently, Duke Energy sponsors the GoGreen program.[38] This program is available for all Duke Energy customers, who can purchase 100 kWh offsets for $2.50. Using the ICLEI software, theoretically every 100 kWh offset results in 214 pounds of $CO_2$ equivalent emissions reductions. However, it is currently unclear how purchase of GoGreen credits translates into purchase of renewable energy. Duke Energyôs description of this program states only that ñDuke Energy will obtain energy from environmentally friendly generating sources located within our service area as they become available. Weôll also purchase renewable energy from third parties in the form of renewable energy credits.ò[39] Increased transparency in Duke Energyôs GoGreen program is needed and citizens should carefully research this option. Other power companies, such as Vermontôs Green Mountain Power, while also charging a premium for renewable energy, allow consumers the choice of purchasing a portion or all of their monthly energy use from certified renewable energy sources.[40]

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[37] ñNet Metering.ò Duke Energy.
http://www.duke-energy.com/pdfs/DE-IN-Standard-Contract-Rider-57.pdf
[38] ñDuke Energyôs GoGreen Power.ò February 7, 2009.
http://www.duke-energy.com/indiana/products/gogreenpower.asp
[39] ibid.
[40] ñAbout Choose2BGreen.ò Green Mountain Power. March 5, 2009.
http://choose2bgreen.com/about.php

There are also actions that can be taken at the municipal level to increase the use of renewable energy. First, an estimated $13,000 was saved from the HVAC improvements at City Hall from 2007 to 2008. This money could be reinvested into renewable energy programs.[41] The Federal government has many programs to assist local governments in funding renewable energy projects. The U.S. Department of Energyôs Energy Efficiency and Renewable Energy Program directs the Alternative Power and Energy Program, which provides financial assistance to the public (as well as commercial, industrial, and agricultural sectors) for installing alternative energy systems for thermal, power generation, and other non-transportation applications of alternative or renewable energy.[42] This program tailors its work to the needs of local municipalities and is geared toward individual states, including Indiana.

Many municipalities, including San Francisco, CA, New York, NY, St. Paul, MN, Chicago, IL, and Dubuque, IA have also taken on initiatives to increase renewable energy. Gavin Newsom, the Mayor of San Francisco, CA has set out an ambitious plan for the city government to obtain 100% of its energy from pollution-free sources. The plan calls for a multi-pronged approach to increase the use of solar, hydro, wind, and other clean energy sources for the city. Key tactics of the plan include:

- Require all city government power to come from clean, renewable sources by 2010
- Create 5-year energy efficiency plans for key city departments
- Streamline city permitting for solar energy systems
- Launch an energy conservation campaign
- Expedite implementation of the cityôs $100 million solar energy bond
- Take advantage of upcoming power contract expirations to switch to wind power
- Require solar to be incorporated in new buildings
- Support energy efficient homes[43]

Some of these tactics are more applicable to Bloomington than others, but illustrate ways the city can become active in increasing renewable energy use.

[41] Personal Communication with Barry Collins and Adam Wason. October 18, 2008.
[42] U.S. Department of Energy. Energy Efficiency and Renewable Energy. http://apps1.eere.energy.gov/state_energy_program/grants_by_state.cfm/state=IN#a200
[43] Clean Energy, Clean Air: A Plan to Increase Renewable Energy Use in San Francisco http://www.sfgov.org/site/uploadedfiles/mayor/PolicyFinance/MayrsCleanEnergyCleanAir.pdf

## SUMMARY

Overall, this report illustrates that a large-scale, concerted effort by public and private interests throughout Bloomington will be necessary to fully meet Bloomingtonôs commitments to mitigate climate change. The total emission reductions discussed in this report are illustrated in Table 4. These measures do not reduce greenhouse gas emissions enough to entirely achieve the goals described by the U.S. Mayors Climate Protection Agreement. However, as an excellent starting point, they provide useful insight into how to best begin reducing greenhouse gas emissions in the community.

Table 4. Summary of potential emission reductions as calculated by CACP software.

| Measure | CO2-Equivalent emissions (tons) | NOx (lbs) | SOx (lbs) | CO (lbs) | VOC (lbs) | PM10 (lbs) |
|---|---|---|---|---|---|---|
| **Public Transportation** | 3,685 | 6,246 | 618 | 377,363 | 35,468 | 229 |
| **Traffic Light Upgrades** | 787 | 2,493 | 5,963 | 216 | 24 | 155 |
| **Street Light Upgrades** | 2,230 | 7,066 | 16,901 | 612 | 67 | 440 |
| **Aggressive CFL Usage** | 179,096 | 567,359 | 1,357,091 | 49,116 | 5,417 | 35,292 |
| **GoGreen Program** | 556 | 1,761 | 4,212 | 152 | 17 | 110 |
| ***TOTAL*** | ***186,354*** | ***584,925*** | ***1,384,785*** | ***427,459*** | ***40,993*** | ***36,226*** |

There are many other possible emissions reduction strategies that are more difficult to quantify. These include:

- Energy audits, HVAC and lighting upgrades in all City facilities
- Flex scheduling for City employees, to reduce amount of travel to and from work
- Comprehensive Energy Star appliance replacement

The impact of these recommendations can be increased by an increased level of public education and community pressure. The Bloomington Commission on Sustainability and the Environmental Commission can help in this educational effort by:

- Creating a website dedicated to sustainable and energy conservation practices in Bloomington, including the motivation for such practices
- Continuing and expanding the campaign for CFL replacement in homes throughout Bloomington
- Continuing to sponsor educational events and programs about energy conservation
- Continued investment in the ICLEI Cities for Climate Protection campaign and CACP software, in order to conduct regular emissions inventories